Høsten 2016

FYS100 Fysikk: Hand-in II

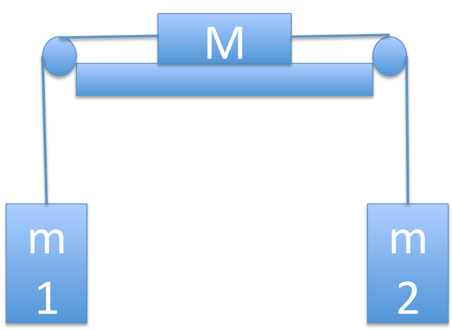
To be handed in at the latest **Friday 30. September, at 18.00**.
You must hand it in by scanning your handwritten solution/compiling your electronic documents into a single .pdf file, and uploading it to It's learning in "Hand-in 2". Mobil-phone pictures are not acceptable.
You **must**:

- Put your name and student number on each page.
- Make an attempt at all separate problems.
- If you don't get to the end of a problem, write a comment why.
- Make sketches for all problems, where it makes sense (vectors, trajectories, forces, ...).
- Write in a readable, well-structured way.
- 3 significant digits.

Failing this, you will be asked to do it again and resubmit.
Pass is 40% correct (including partial credit). There is no grade. You will have a chance to resubmit, if you fail to meet the requirements the first time. But don't plan for several iterations!

Good luck!

Problem 1: Braking an elevator.



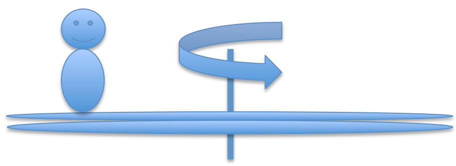
A lifting system can be modelled as two blocks of mass m_1 and m_2 hanging from two pulleys, connected by ropes to a third block of mass $M = 100$ kg, lying on top of a horizontal surface. There is gravity $g = 9.80$ m/s^2.

a) Ignoring at first friction, find an expression for the acceleration of the blocks, as a function of the masses and gravity.

b) Now, we assume that the system starts at rest, and that there is static friction between the block M and the surface it is lying on. How much difference in mass can m_1 and m_2 have, for the system to not start moving, if the coefficient of static friction is $\mu_s = 1.00$? Provide an expression as well as a numerical value.

c) Next, we assume that the system is moving with an initial speed $v_i = 2.00$ m/s, when suddenly kinetic friction between M and the surface is triggered (the brakes are switched on). The coefficient of kinetic friction is $\mu_k = 0.700$. How long does it take for the system to stop if $m_2 = m_1 = 100$ kg ? Provide an expression as well as a numerical value.

Problem 2: Big Brother



A child is at a playground, and chooses to try the spinning disc (see figure). The radius of the disc is 2.00 m, and the coefficient of static friction between child-surface and disc-surface is $\mu_s = 0.350$.
In the following questions, you must provide algebraic equations as well as final numbers.

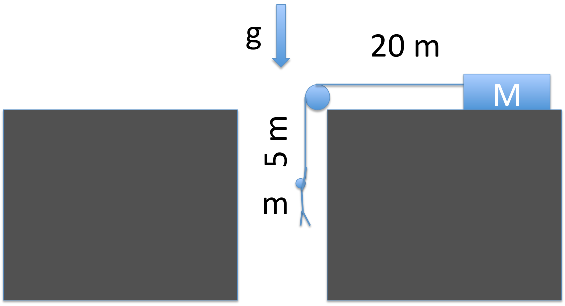
a) If the child sits 1.50 m from the centre, how fast can the spinning disc turn, without her slipping off?

b) The evil big brother now spins the disc with $\omega = 2.00$ rad/s. At what distance from the centre of the disc should the kid sit, to avoid falling off?

Having safely moved to the radius 0.500 m, the child starts complaining, because she cannot get off the ride. The evil big brother decides to stop the rotating disc, by providing a constant tangential force.

c) How quickly can he stop the disc, without her sliding in any direction (neither forwards, backwards, inwards or outwards)?

Problem 3: Chuck Norris.

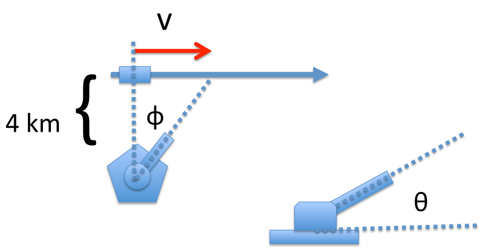


A man (Chuck Norris) of mass $m = 80.0$ kg hangs from a rope down into a hole. The rope goes over a massless pulley and is connected to a block of rock of mass $M = 200$ kg, which is lying on a frictionless horizontal surface. The distance between pulley and man is 5.00 m; between pulley and block 20.0 m.

a) What is the acceleration of the man (and rock)? How long does it take before the block crashes into the pulley, rips it off and everything plunges into the hole? The block and man start from rest.

b) Instead of just hanging there, the man decides to climb up the rope while everything is moving. Is it possible for him to get enough (constant) acceleration to get to the pulley and to safety, before the block hits the pulley? What is the acceleration of him and of the block in the case where he *just* makes it (Chuck Norris does not need to make room for errors; errors need to make room for Chuck Norris).

Problem 4: Tesla-targetting (a bit hard; see how far you get...).



A Tesla comes driving along straight road, at $v = 40.0$ m/s. You are operating a cannon, situated at a distance of 4.00 km from the initial position of the car (see figure). You shoot projectiles with an initial speed of 800 m/s, and you may ignore air resistance, friction and fictitious forces. There is gravity $g = 9.80$ m/s^2.

a) In which direction (in 3 dimensions, see the definition of the angles θ and ϕ in the figure) should you shoot your projectile in order to hit the Tesla? Is there more than one solution? Assume that you shoot at the moment depicted in the figure.

b) How long will it take the projectile to hit the target?

c) How far will the Tesla have travelled when it is hit (from the time, when you shot)? How far will the projectile have travelled horizontally?

d) How high in the air does the projectile go?